barriers rotationally aligned, the built up laminations will create what is known as a stack and form a flux void or barrier in the tooth regions within the stack, running parallel to the axis (**X1**) of the rotor shaft, through the laminations. The flux barrier can be continuous as shown in FIG. **2***a* as per the prior art JP4797227B2. In accordance with aspects and embodiments of the invention the non-continuous flux barrier may be multiply non continuous as per FIG. **3** or FIG. **4** or non-continuous as per FIG. **3***a* depending on the combinations of punched and non punched pressed laminations used during stack assembly.

[0062] In FIG. **2** the rotor flux barrier (**26**) is shown as being offset from the centre line (CL**1**) of the rotor tooth towards surface (S**1**) and the stator flux barrier (**28**) is offset the other way from stator tooth centre line (CL**2**), towards surface (S**4**). These offsets are deliberate so that when the rotor tooth moves in the direction of arrow (A) and as the flux barriers pass each other, the forces acting across the air gap may be influenced in an advantageous way, for example by improving the smoothness of torque delivery or reducing torque ripple from the motor output shaft.

[0063] The offset of the rotor flux barrier (**26**) from the centre line (CL**1**) of the rotor tooth can be more or less than the offset of the stator flux barrier (**28**) from stator tooth centre line (CL**2**) and advantageously this can help with smoothing torque output from the motor as the rotor tooth passes the stator pole by changing the flux path through low reluctance regions.

[0064] When comparing FIG. **1** with FIG. **2**, which are shown with teeth in the same relative position, it can be seen that the number of flux lines (**16**) acting across the air gap (**14**) is **6** in FIG. **1** and only **4** in FIG. **2**. This illustrates that at this point of rotation the magnetic field will be acting more strongly in the rotor without flux barriers as it has more active flux lines and the forces will be higher across the air gap. The presence of the flux barriers excludes the possibility of flux lines flowing across the overlapped rotor teeth and stator pole at this angular rotation, thus weakening the torque effect on the rotor at this time. Essentially this delays the application of maximum torque on the rotor as will be shown later. The continuous flux barrier shown in FIG. **2** runs axially all the way through the rotor and stator stack lengths without a break, hence being continuous as described in relation to prior art document JP4797227B2.

[0065] In the embodiment as shown in FIG. **2**, if the motor rotor is run in the opposite direction to arrow (A) the torque output characteristics will be different, It may be that the torque output has more ripple but that the average torque output is higher. This can be advantageous in a vehicle as it is common to design reverse gear to have more torque capability in the reverse direction than forward such that the driver can always reverse out of a gradient they drive into. So it may be preferable to design the rotor to rotate in the direction of arrow (A) as a predominantly forward direction thus giving more smooth torque delivery in the majority of driving conditions, but having a higher torque capability in the reverse direction where the increased noise potential is traditionally less important.

[0066] The timing of the inverter control for the 3 phases may be changed to better tune the torque output to fit in with the modified motor flux lines caused by the flux barriers. With continuous flux barriers, positive torque will be available over a longer period, so a lower current over a longer conduction period could help to smooth torque ripple.

[0067] The flux barrier in this case maybe simply be an air void or it could comprise any non ferrous material such as plastic, ceramic material or another metal. The flux barrier could be in only one of either the rotor tooth or stator tooth. The flux barrier as per the invention may be a non-continuous flux barrier with spaces along the flux barrier axis that are not flux barriers filled with normal electrical steel. The flux barriers in the case of the proposed invention are non continuous so may be multiple and separated by electrical steel as an example.

[0068] The prior art JP4797227B2 identifies continuous flux barriers with the aim of reducing radial force generated motor casing noise, whereas the proposed invention using non continuous flux barriers seeks to reduce the motor output torque ripple (shaft angular torque variation and torsional shaft vibrations) which may cause different noise problems, particularly around a vehicle if fitted to one.

[0069] FIG. **3** in accordance with the invention shows an example cross section taken through the axis (X**1**) of the motor shaft (**33**) and shows multiple non continuous flux barriers which share common axes (X**2**,X**3**) parallel to the shaft axis (X**1**). In this example the rotor tooth (**32**) has **4** non continuous flux barriers (**36**) sharing a common axis (X**2**) and the stator (**30**) has **4** non continuous flux barriers (**38**) sharing a common axis (X**3**). In this example the flux barriers are axially aligned with each other across the airgap (**34**) and pass each other as the motor rotates. The non continuous flux barriers (**36**,**38**) are aligned in this example along, for example, the radial line (Z**1**) shown in FIG. **3**.

[0070] In this example the flux barriers run along the (X**2**) and (X**3**) axes and they comprise 50% of the axial length of the rotor/stator in alternate segments. The spacing between the non continuous (segmented) flux barriers in this example is filled with electrical steel. The respective percentages of flux barrier segments and electrical steel between them can vary along the (X**2**,X**3**) axes.

[0071] It can be seen from FIG. **2** that the flux lines (**16**) are not able to run through the flux barriers (**26**,**28**) as there is no magnetic medium present to transmit the flux lines. The flux lines follow the path of lowest reluctance, which in the case of an axially continuous void will mean being diverted around it as shown in FIG. **2**. This effective exclusion of flux lines because of the presence of the flux barrier weakens the magnetic field across the air gap (**24**) and reduces the instantaneous torque capability.

[0072] FIG. **4** is a 3D sketch of an embodiment of an example distribution of flux barriers along a rotor tooth as per the invention. The rotor tooth (**42**) shown shows embedded flux barriers (**46**) along the length of the tooth, which would not be visible to the eye when viewed externally.

[0073] The number of flux barriers which can be embedded inside the rotor and or stator can be determined by the aspect ratio of the flux barrier. It is important that the aspect ratio of the flux barrier (**46**) gives a flux barrier which is longer in the (X) axis than the width in the (Y) axes, as shown with the flux barriers (**46**) in FIG. **4**. It must be ensured that the direction of the flux lines takes a path which must run parallel to the (Y) and (Z) axes (ie: in the YZ plane) and follow the layers of the laminations. This ensures that the lines of force act in the same plane as the direction of rotation of the motor and deliver maximum effect for reduction of torque ripple.

[0074] Note, if the length of the non continuous flux barriers in the X (ie; X**2**,X**3**) axes were too short because not